Gulf of Mexico Miocene CO_2 Site Characterization Mega-Transect

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BUREAU OF ECONOMIC GEOLOGY
THE UNIVERSITY OF TEXAS AT AUSTIN

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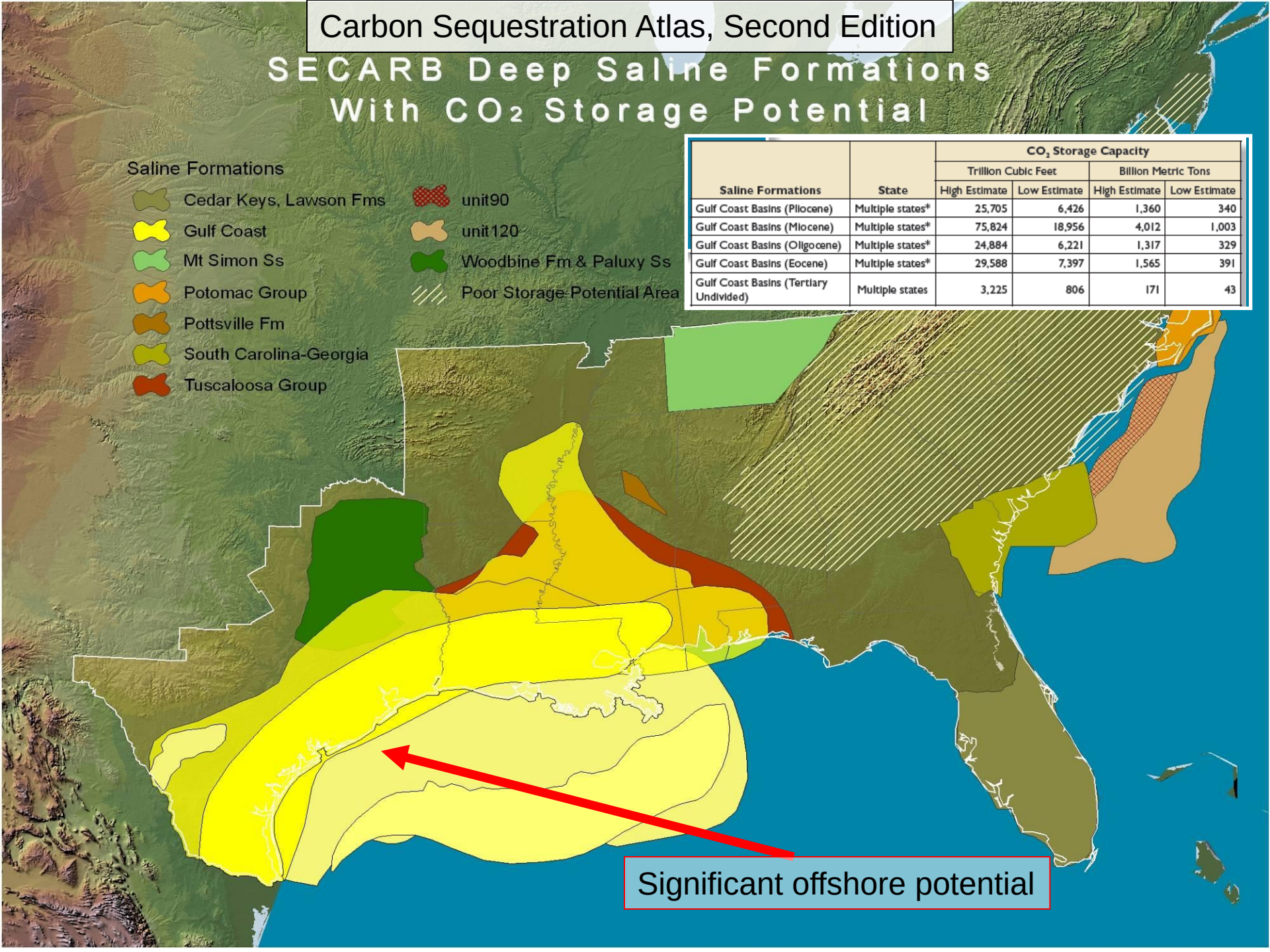
Participants

- NETL, Bruce Brown
- The University of Texas at Austin
  - *Gulf Coast Carbon Center, Bureau of Economic Geology*
  - *Institute for Geophysics*
  - *Petroleum and Geosystems Engineering*
- Los Alamos National Laboratory
- Environmental Defense Fund
- Sandia Technologies

Carbon Sequestration Atlas, Second Edition

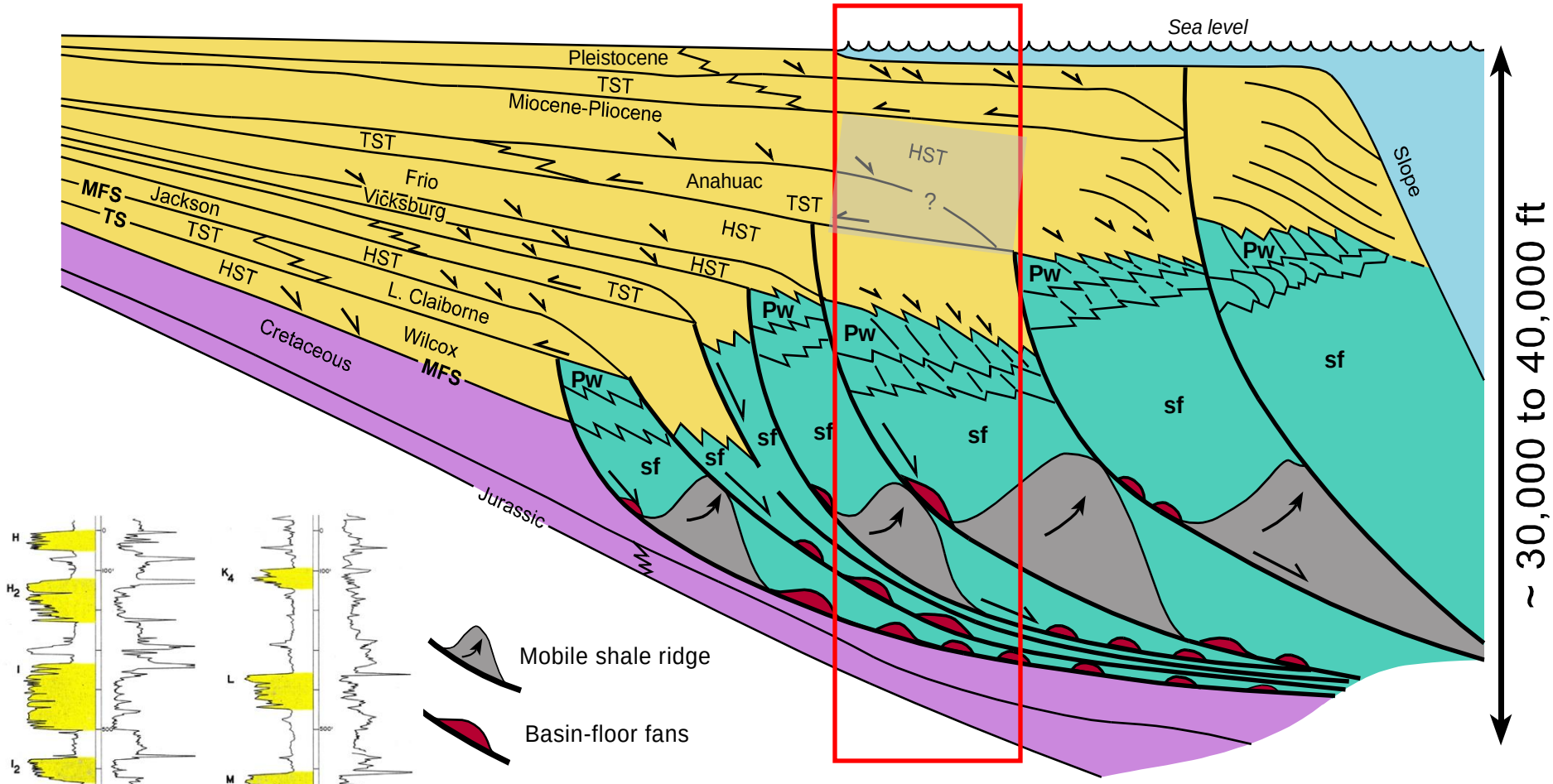
SECARB Deep Saline Formations With CO_2 Storage Potential

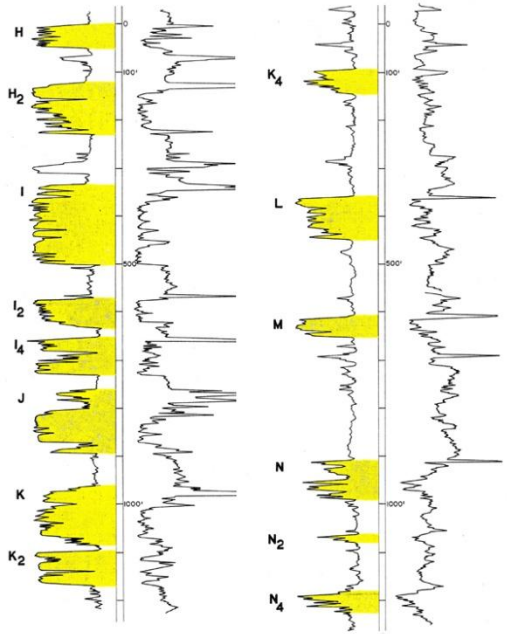


Saline Formations	State	CO_2 Storage Capacity			
		Trillion Cubic Feet		Billion Metric Tons	
		High Estimate	Low Estimate	High Estimate	Low Estimate
Gulf Coast Basins (Pliocene)	Multiple states*	25,705	6,426	1,360	340
Gulf Coast Basins (Miocene)	Multiple states*	75,824	18,956	4,012	1,003
Gulf Coast Basins (Oligocene)	Multiple states*	24,884	6,221	1,317	329
Gulf Coast Basins (Eocene)	Multiple states*	29,588	7,397	1,565	391
Gulf Coast Basins (Tertiary Undivided)	Multiple states	3,225	806	171	43

Tremendous capacity in offshore wedge

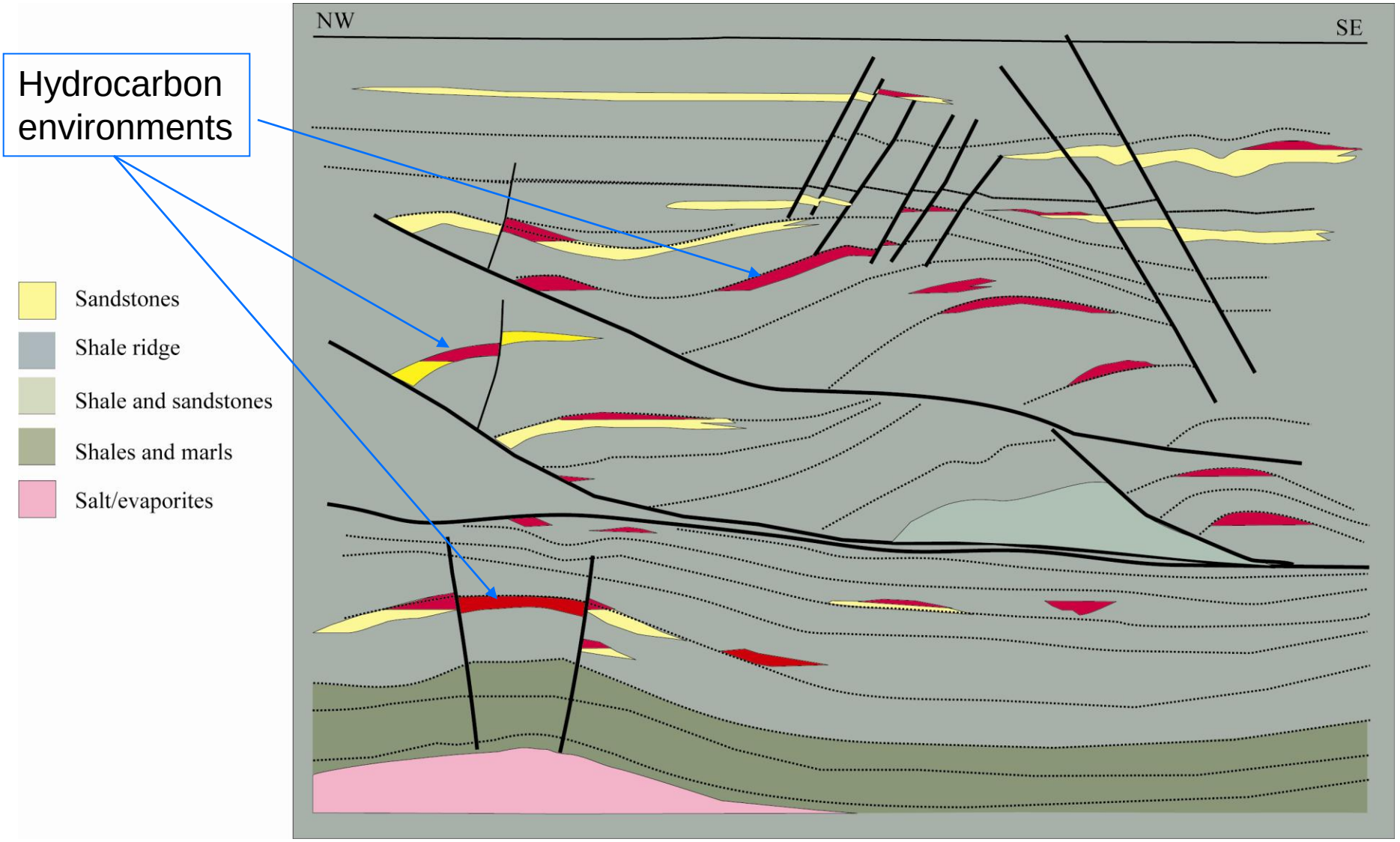
Prograding wedge of fluvio-deltaic sediments in upper Miocene stratigraphy





Modified from Bebout and Loucks (1981)

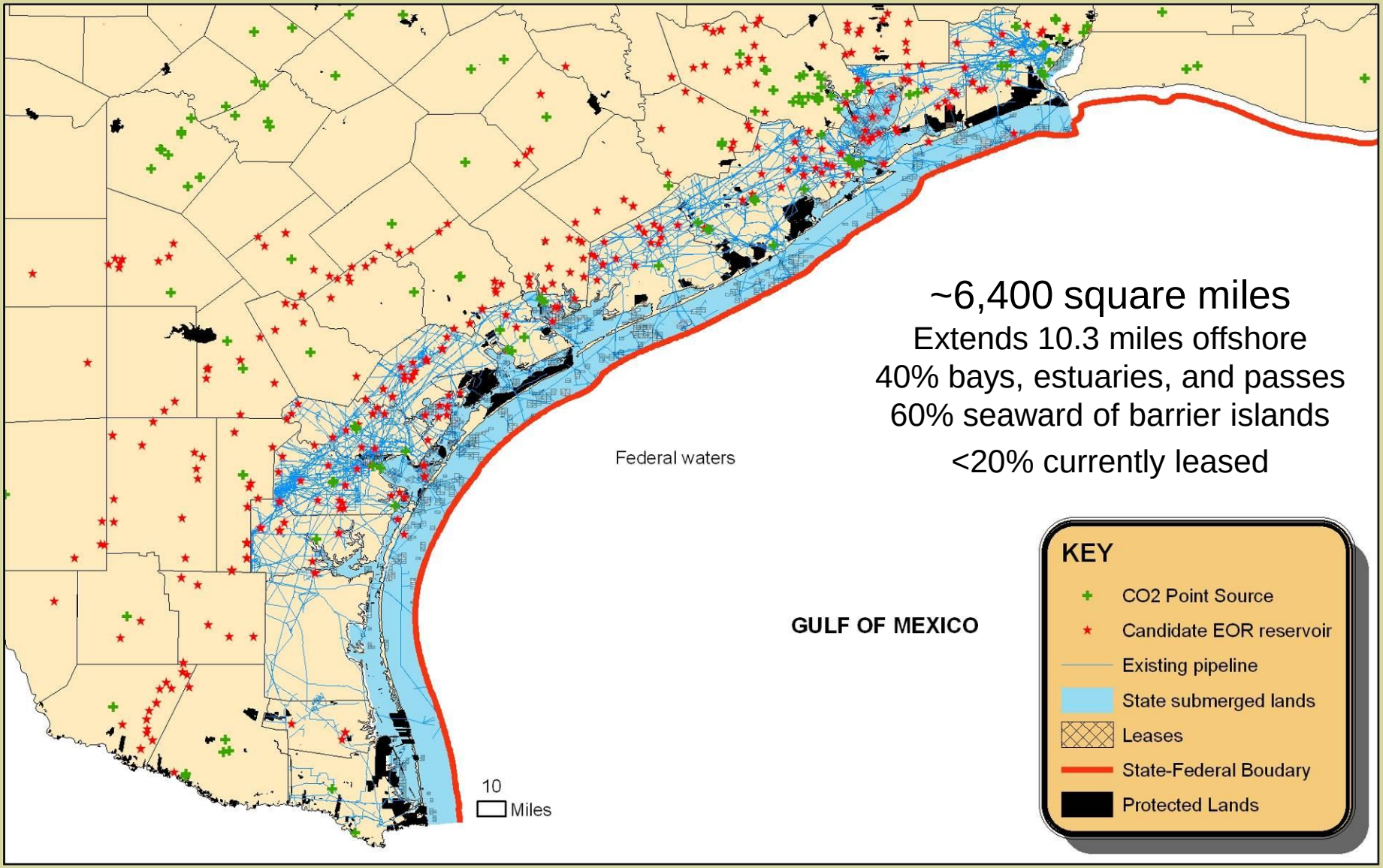
Variety of settings for viable traps



Courtesy of Angela McDonnell, BEG

Offshore State-owned lands

Additional assurance is needed regarding capacity and containment

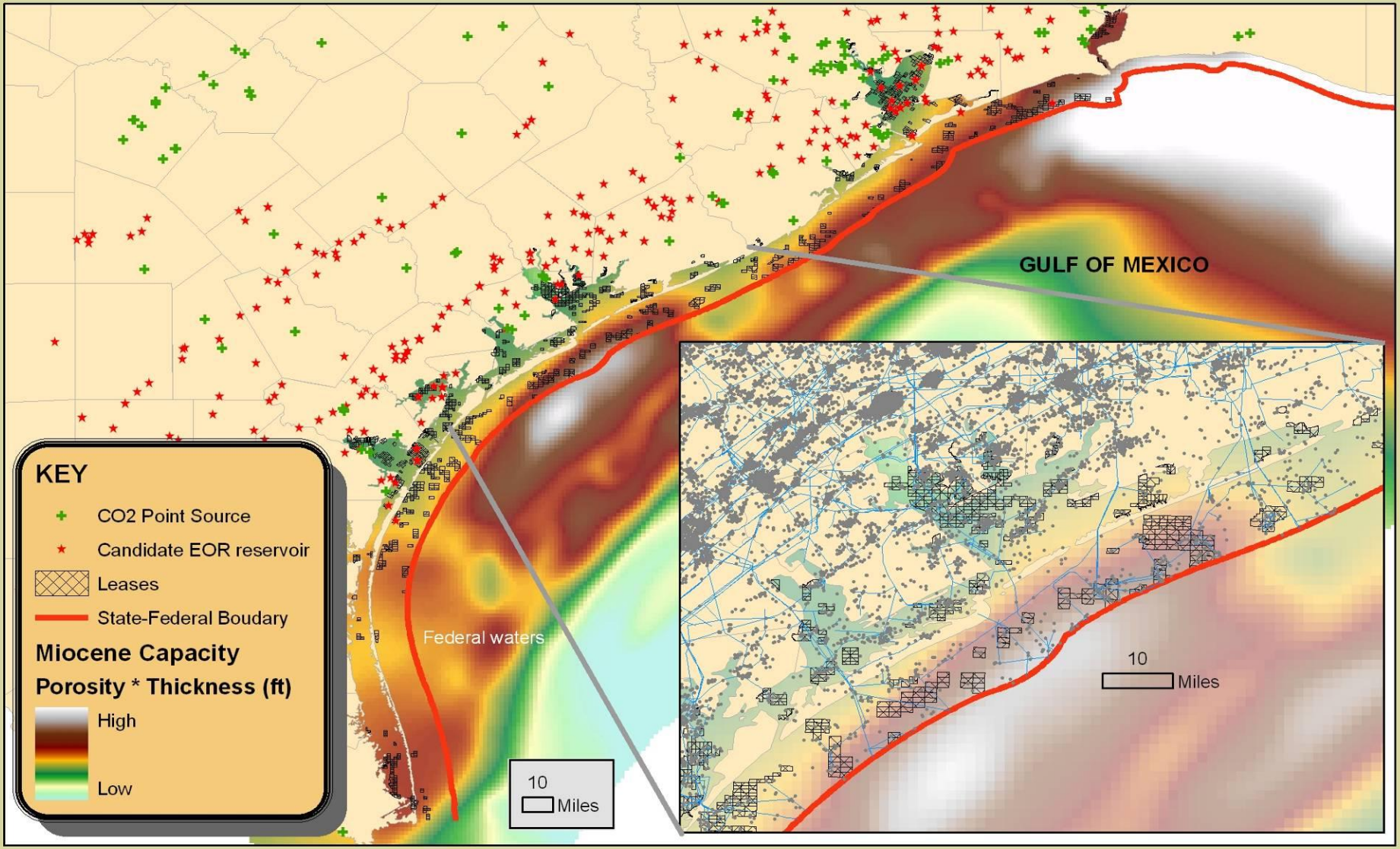


Texas State Offshore Lands & CCS

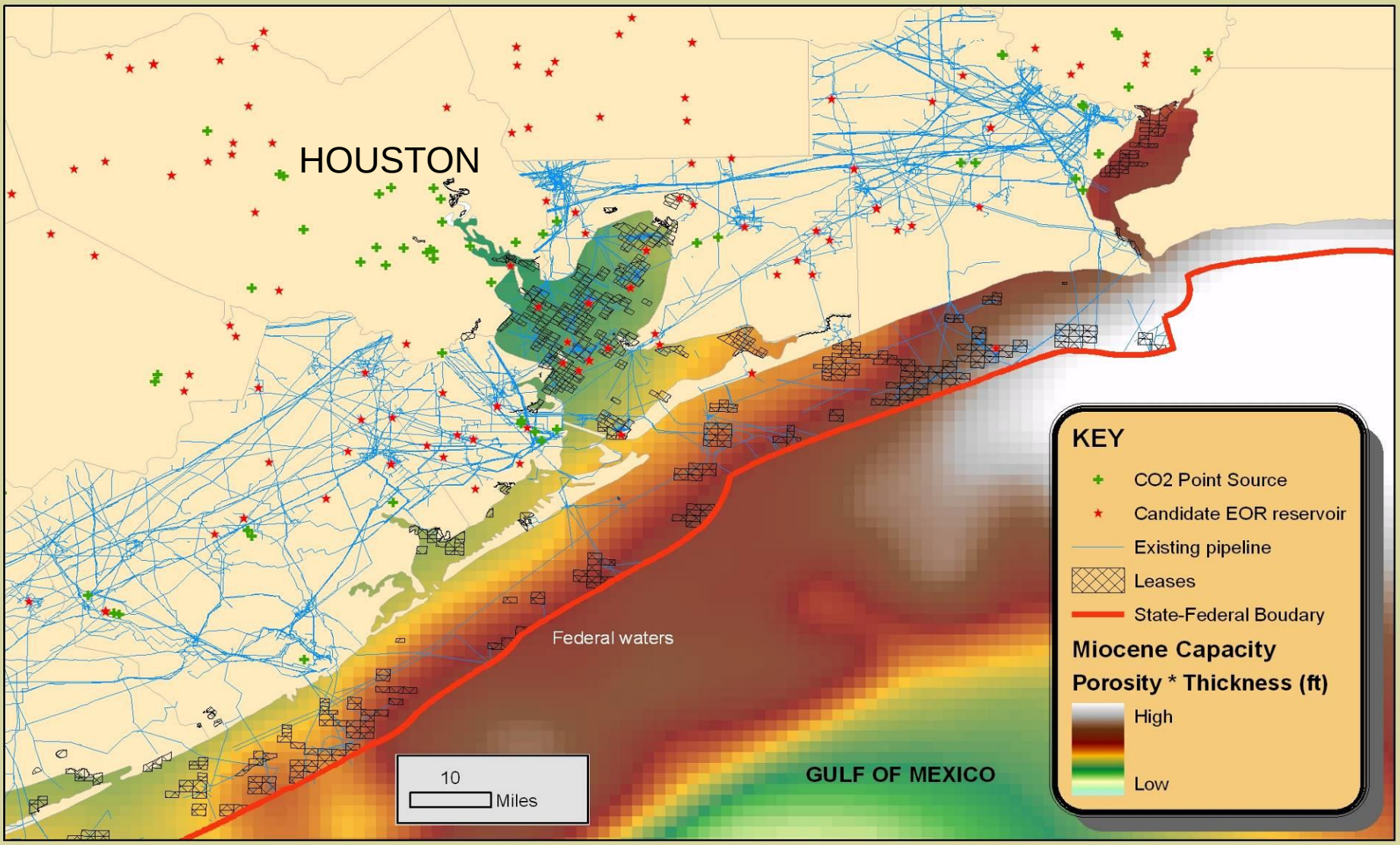
- General Land Office (**GLO**): Revenues to Permanent School Fund (lower taxes) - $11B since 1854
- **HB 1796** (2009) – Offshore CCS feasibility study ($1.2M; GLO)
- **NETL FOA-33**: Characterization ($4.8M)

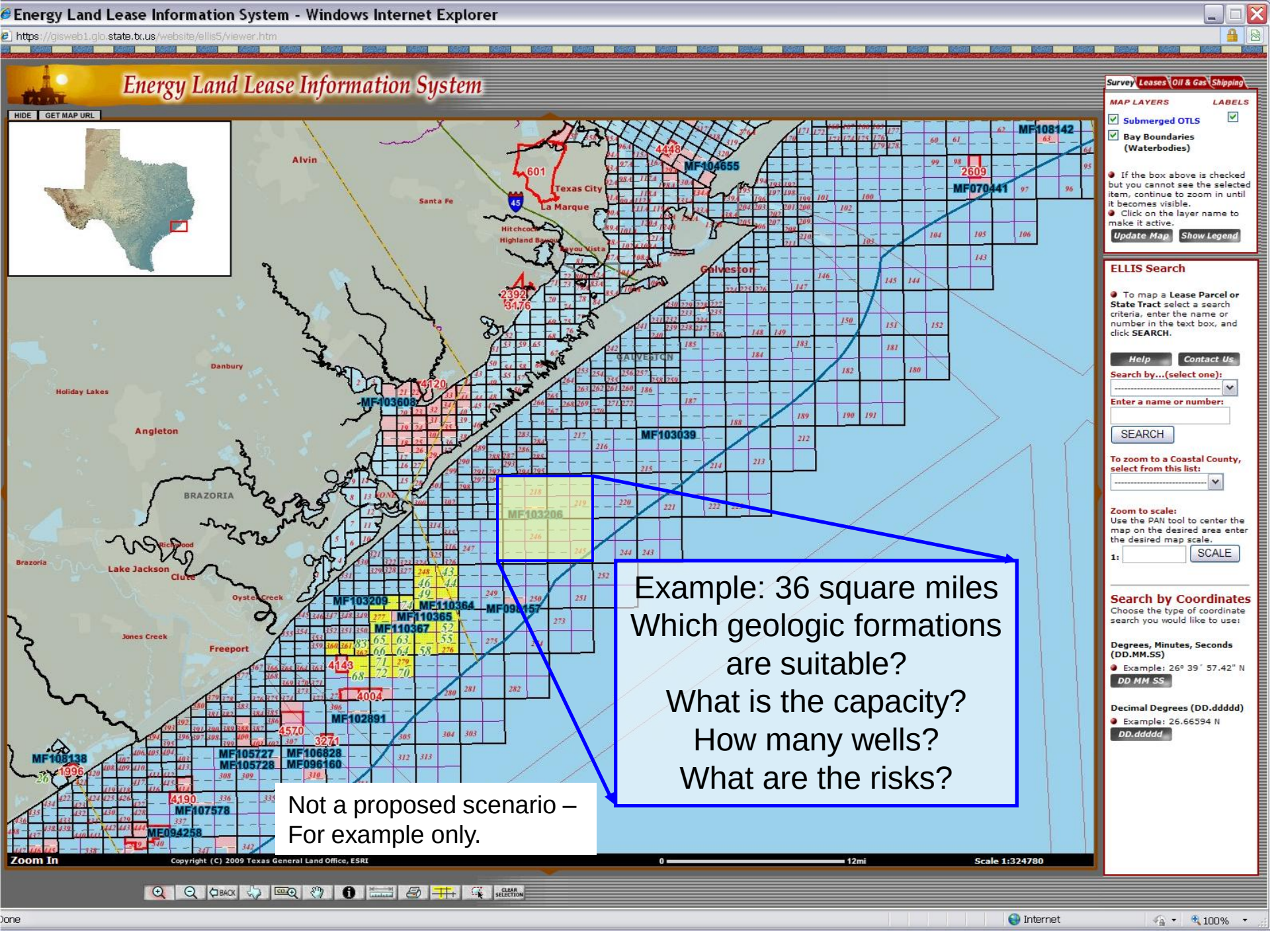
- **Single land owner** avoids NUMBY, pore space ownership, trespass, and liability issues.
- Reduced risk to **USDW** (protected groundwater)
- **Monitoring** techniques exist and can be applied to CCS, but have not to date in U.S.
- **Risks** need thorough evaluation
  - LANL : CO2-PENS
  - Environmental Defense Fund
  - Utilize evolving international experience
    - Sleipner (Statoil-Hydro)
    - Australian acreage release
    - UK feasibility study

CO_2 Brine Storage Capacity



CO_2 Brine Storage Capacity




Energy Land Lease Information System - Windows Internet Explorer
https://gisweb1.glo.state.tx.us/website/ellis5/viewer.htm
Energy Land Lease Information System
HIDE
GET MAP URL
Survey
Leases
Oil & Gas
Shipping
MAP LAYERS
LABELS
Submerged OTLS
Bay Boundaries (Waterbodies)
If the box above is checked but you cannot see the selected item, continue to zoom in until it becomes visible.
Click on the layer name to make it active.
Update Map
Show Legend
ELLIS Search
To map a Lease Parcel or State Tract select a search criteria, enter the name or number in the text box, and click SEARCH.
Help
Contact Us
Search by...(select one):
Enter a name or number:
SEARCH
To zoom to a Coastal County, select from this list:
Zoom to scale:
Use the PAN tool to center the map on the desired area enter the desired map scale.
1:
SCALE
Search by Coordinates
Choose the type of coordinate search you would like to use:
Degrees, Minutes, Seconds (DD.MM.SS)
Example: 26° 39' 57.42" N
DD MM SS
Decimal Degrees (DD.ddddd)
Example: 26.66594 N
DD.ddddd
Alvin
Santa Fe
Texas City
La Marque
Hitchcock
Highland Bayou
Bayou Vista
Galveston
GALVESTON
Danbury
Holiday Lakes
Angleton
BRAZORIA
Brazoria
Lake Jackson
Clute
Richwood
Oyster Creek
Jones Creek
Freeport
MF108142
MF104655
MF070441
MF103608
MF103039
MF103206
MF103209
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MF108138
MF107578
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4448
601
2609
2392
3176
4120
4143
4004
4570
3271
4190
1996
Example: 36 square miles
Which geologic formations are suitable?
What is the capacity?
How many wells?
What are the risks?
Not a proposed scenario – For example only.
Zoom In
Copyright (C) 2009 Texas General Land Office, ESRI
0
12mi
Scale 1:324780
Internet
100%

Tasks

- **Task 1: Project Management, Planning, and Reporting (Trevino, Meckel)**
- **Task 2: Regional Significance (Meckel, Carr, Hovorka)**
  - **Subtask 2.1: Atlas of prospective sequestration 'plays'**
    - **Structure contour, isopach, cross sections**
    - **Reservoirs and seals**
  - **Subtask 2.2: Comprehensive data set of formation characteristics**
    - **Texas Railroad Commission, General Land Office**
    - **Poro, perm, injectivity, mineralogy, fluids**
  - **Subtask 2.3: Best practices for site characterization**
    - **Conveyed to technical working groups on characterization**
- **Task 3: Site Capacity Estimates (Meckel, Hovorka, Nicot, URA)**
    - **Regional upper Miocene**
    - **Local highly-prospective reservoirs**
    - **Meet DOE goal of +/- 30%**
  - **Subtask 3.1: Coordination with NATCARB database**
- **Task 4: Site Injectivity (Trevino, Nicot, Zeng, Carr, Bryant, PhD student)**
  - **Subtask 4.1: Data collection / Analysis:** Task 2.2; Petrel
  - **Subtask 4.2: Simulation**
    - **GEM, Eclipse, Kappa Ecrin**
    - **Meet DOE goal of 30 MT or lifetime of plant**
- **Task 5: Site Stratigraphic Containment (Meckel, Carr, Lu, PhD student, URA)**
  - **Subtask 5.1 Modeling:** Permedia MPath + CO2 Toolkit; 99% containment 1,000 yrs
  - **Subtask 5.2: Caprock Seal Capacity:** BEG CRC

Tasks - continued

- **Task 6: Brine Containment (Romanak, Zhang, Nicot)**
  - **Laboratory hydrothermal simulations:** autoclave reaction system- reaction rates
    - **Optical sapphire window reaction system + high temperature pH probe and Raman spectroscopy; SEM & AFM**
  - **Aqueous phase modeling**
- **Task 7: Mineralization Containment (Romanak, Zhang, Yang)**
  - Phreeqc & Geochemist's Workbench: equilibrium and kinetics
- **Task 8: Leakage Pathways (Meckel, Lu, Hornback)**
  - Badley's TrapTester: SGR, effective stress (3D survey in La Vaca Bay example)
  - Permedia MPath: long-term migration, sub-basin scale, 10^2-10^3 yrs
- **Task 9: Site Selection (Trevino, Meckel, Hovorka):** Go/No-Go decision
- **Task 10: Risk Assessment (Pawar-LANL; Anderson-EDF; Duncan-BEG)**
  - **Subtask 10.1: CO2-PENS analysis (Pawar)**
  - **Subtask 10.2: Identification of environmental risks specific to offshore settings (Anderson, Duncan)**
- **Task 11: Well Bore Management (Trevino, Collins)**
  - **Subtask 11.1: Wellbore Evaluation for Wells Within Study Area**
  - **Subtask 11.2: Draft Wellbore Management Plan**
- **Task 12.0: Produced Fluid Management**

Research Development

AIMS: Identify where greatest uncertainties are through thorough characterization and collect additional data to reduce those uncertainties, facilitating near-term commercial utilization.

Phase I

Years 1-2: Characterization effort & Site selection

- Capacity
- Injectivity
- Stratigraphic containment
- Caprock seal capacity
- Brine containment
- Mineralization containment
- Leakage pathways

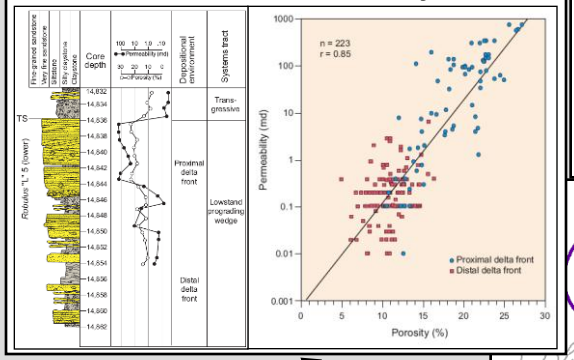
Phase II

Year 3: Uncertainty reduction via additional data collection

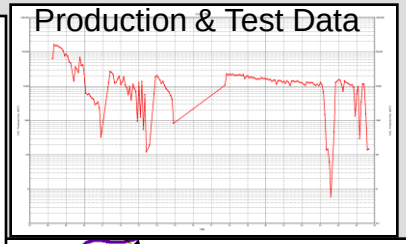
- Test well, core measurements
- Equivalent surface monitoring design and demonstration + modeling & simulation
- Marine survey (shallow seismic / bathymetry / water column)

Examples of Characterization Data

Cores & Core Analysis*



Production & Test Data



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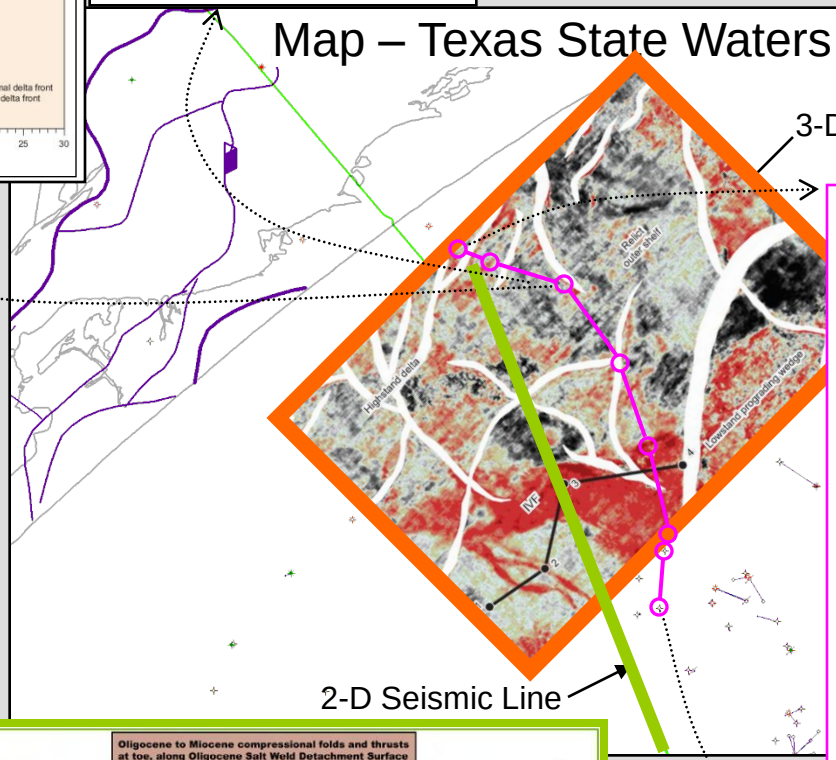
103,239 BBLS
149,670 BBLS

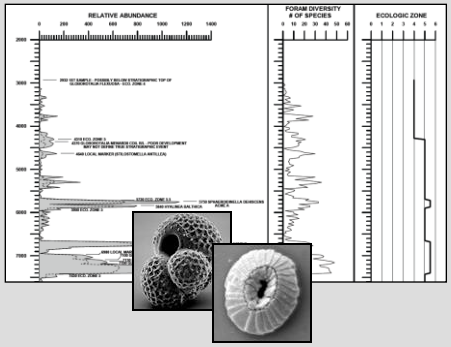
Map – Texas State Waters



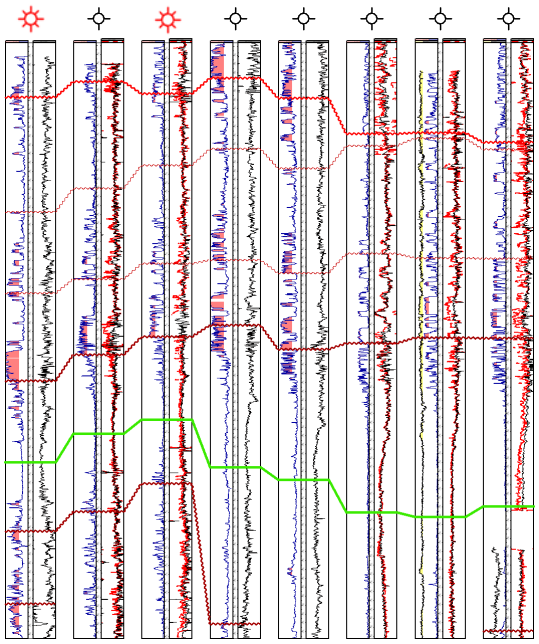
3-D Seismic Survey**

2-D Seismic Line

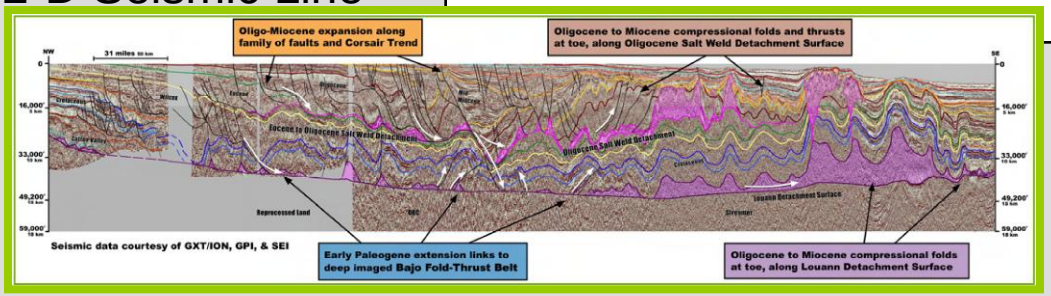
Paleo Data



Well-Logs in a Cross Section



2-D Seismic Line



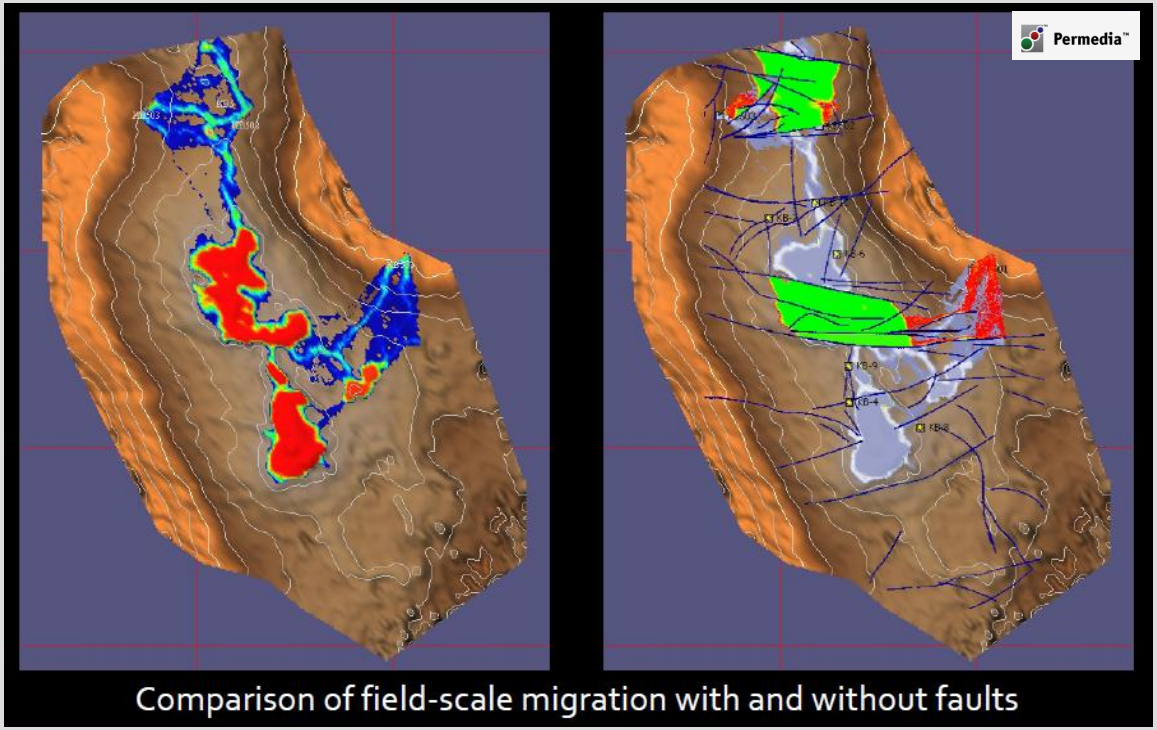
* From Dutton and Hentz (2002)

** From Zeng and Hentz (2004)

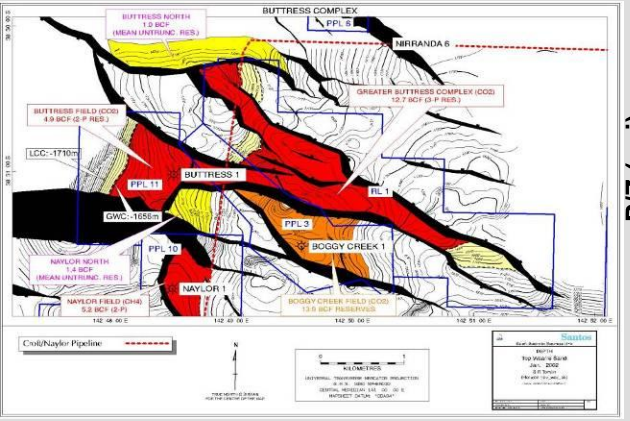
Modeling & Simulation

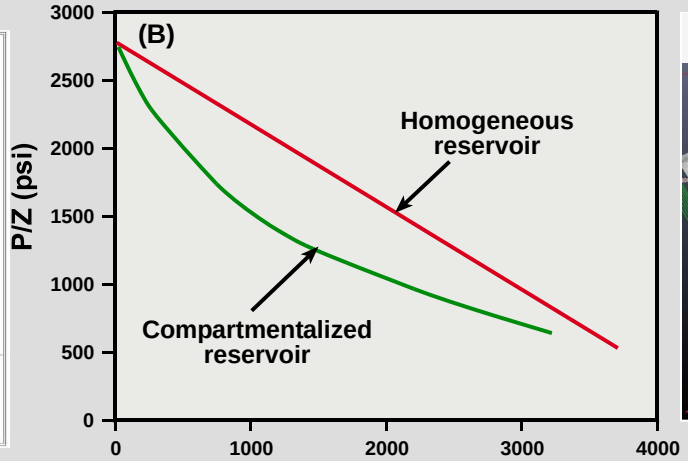
Focus on:

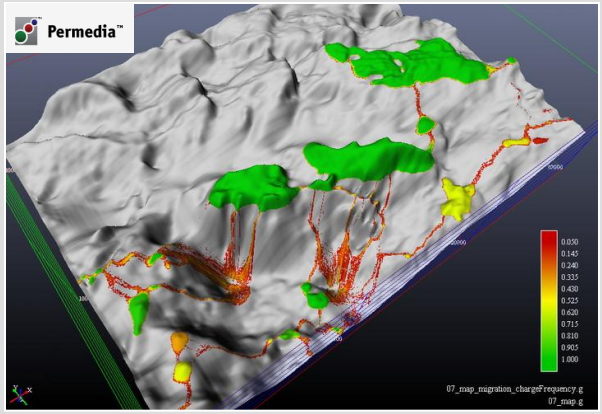
- Reservoir capacity (site)
- Potential long-term migration (invasion percolation techniques)
- influence of faults (compartmentalization)
- Pressure evolution



Comparison of field-scale migration with and without faults







Risk Assessment for Offshore CCS

Pawar & Carey, LANL; Anderson, ED; Duncan, GCCC

Los Alamos National Lab:

CO2-PENS is a coupled process-systems model that integrates field/laboratory observations with numerical models and abstractions to predict long-term performance of a geologic CO_2 sequestration site. The model accounts for CO_2 migration in the primary reservoir and beyond through potential leakage pathways such as wellbores, faults etc.

Gulf Coast Carbon Center:

- Compile & review available technical literature on risks of offshore sequestration
- Gather data relevant to studies by LANL and EDF
- Liasson to LANL and EDF

Environmental Defense:

Nationally recognized environmental advocate tasked with independent assessment of potential risks. Collect information on the various concerns of regional stakeholders.

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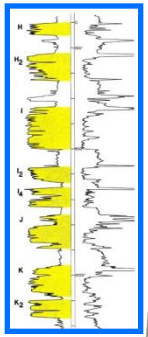
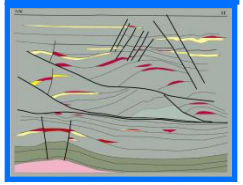
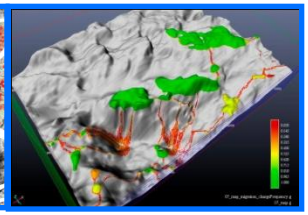
Characterization & Capacity





Environment

Containment



Texas Offshore Geologic Carbon Storage Project

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